AMATEUR WORK

A MONTHLY MAGAZINE OF THE USEFUL ARTS AND SCIENCES

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WOODEN TURNING-LATHE FRAME.

A TURNING lathe adequate to the needs of most amateur workers costs more than many can afford to expend for this very desirable tool. By making the bed, drive-wheel and treadle here described, and purchasing the head and tail stocks and rests, a very serviceable lathe can be obtained at comparatively small expense. At the request of several readers of the magazine, the description here presented is designed for the lathe set offered as a premium in the April number. It can easily be altered to the lines of other lathe sets, by slight changes in the bed and drive-wheel. The same kind of wood should be used for all parts except where a special wood is specified. Before making the lathe, a drawing one-half size should be made on some large sheets of smooth Manilla wrapping paper. This will greatly simplify the work to one who is not familiar with it.

For the bed will be required two pieces, A, of maple or hard pine, 4′ long, $3\frac{3}{4}''$ wide and $1\frac{3}{4}''$ thick. These should be very carefully planed down at the lumber mill from larger stock, so that all sides will be square and true. Between the pieces A at each end, are placed pieces of maple or oak, B, $4\frac{1}{2}''$ long, 3″ wide and $\frac{13}{16}''$ thick. These are bolted together by two bolts at each end, 5″ long and $\frac{1}{2}''$ in diameter, the heads on the front side being countersunk to make them flush.

The top edge of the bed should be exactly even and square, so that, in moving the tail stock, the latter will not be out of line at any point. The legs, C, are 2′ $5\frac{1}{2}''$ long, 4″ wide and 3″ thick. This length brings the top of the bed 30″ from the floor. The lower ends are beveled, as shown in Fig. 1, and the upper ends cut to fit the bed-pieces. The vertical cut at the top is $2\frac{1}{2}''$, and the horizontal cut $1\frac{1}{4}''$ long. The crosspieces, D, are made from the same stock as the legs, and on the lower side are $13\frac{1}{2}''$ long. This allows for tenons 2″ long, on each end, to fit mortises in the legs C. These mortises are 2″ wide and $2\frac{1}{2}''$ high,

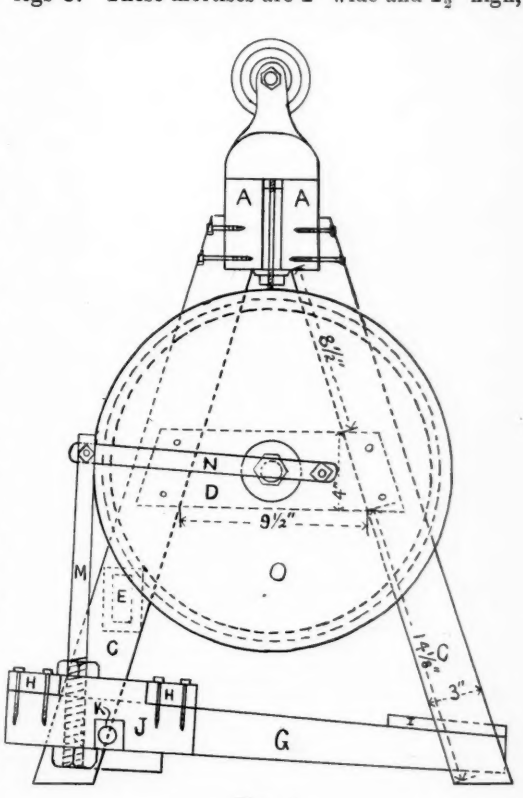


FIG. 1.

and should be well fitted so that the frame will be as rigid as possible. The pieces D are fastened at each end by gluing and also with $\frac{3}{8}''$ dowel-pins. Mortises 2″ by 1″ and $2\frac{1}{2}''$ deep should

also be cut in the two rear pieces, C, for the tenons on the cross-piece, E. The crosspiece, E, is 3′ ½″ long, 3″ wide and 2″ thick, with tenons on each end 2″ long, to fit mortises in pieces C. The lower edge of the crosspiece is 7½″ from the floor. The ends are fastened to pieces C by gluing and two ⅜″ dowel-pins in each end.

The centers of the holes are 2½″ from the floor on the center line, and one-half of the holes should be in each piece. Great care must be taken to see that they line correctly, to prevent binding. A 1″ hole is also bored through the center of the piece D, on the left side of the frame, to receive the bolt which holds the drive-wheel. The center

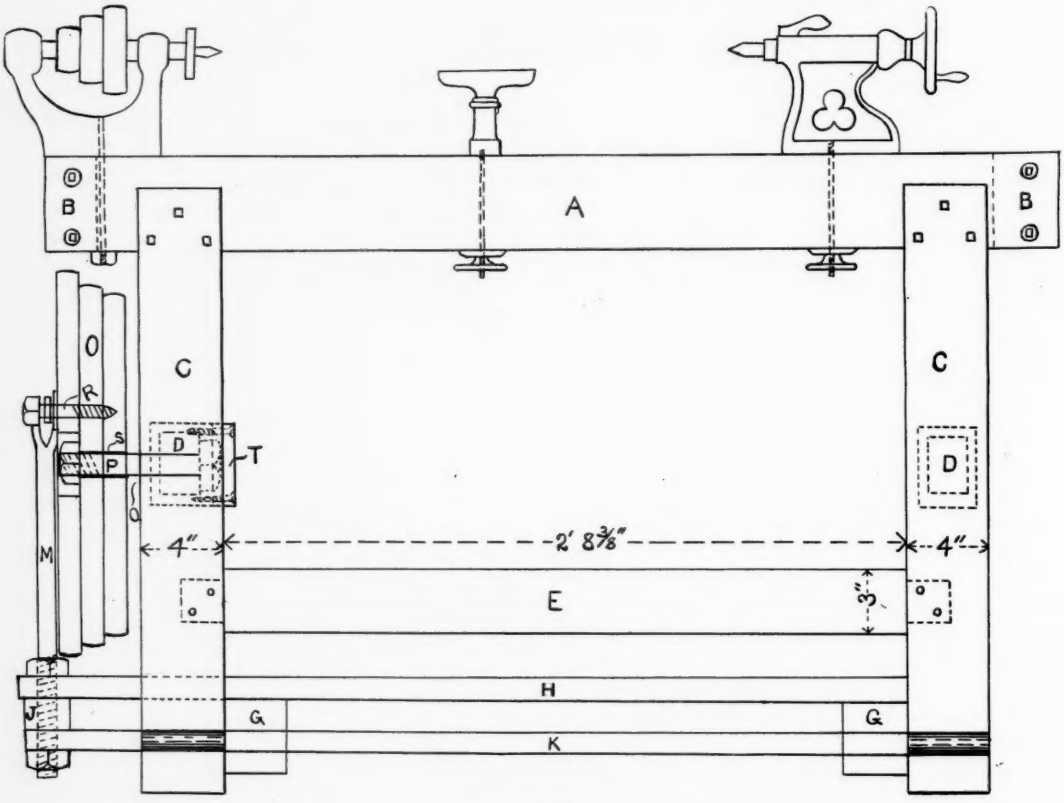


Fig. 2.

At the bottom and on the inside of the two rear pieces C, are two pieces, F, which are 5″ long, 4″ wide and 2″ thick (Fig. 3). The lower ends of these pieces are cut to the same bevel with the legs. They are bolted to the legs with two bolts 5″ long and ⅜″ diameter, the heads being countersunk. The faces of both legs and pieces should be smooth and true, as they make the bearing for the treadle-shaft. After the frame is finally set up, holes, 1″ in diameter, are bored through the center of the joint.

of this hole is 15½″ from the floor. If a straight piece of wood be laid across the tops of the pieces D, over where the hole is bored, it will assist in getting the hole correctly lined. This is very essential, as if not true the drive-wheel will wabble when running, causing the belt to slip off.

The treadle is made of two pieces, G, 25″ long, 3″ wide and 2½″ thick on the rear ends, tapering down to 1½″ thick on the front ends. The two pieces H are 4½″ long, 2½″ wide, 1″ thick, and are finally screwed to pieces G. The front piece

H is 4½″ from the rear piece. The foot piece, I, is 32″ long, 6″ wide and 1″ thick, and preferably should be of oak, the better to withstand the wear. It is firmly screwed by the two pieces G. The piece J is 9½″ long, 3½″ thick and 2″ wide, and is cut to the shape shown in Fig. 2. It is attached to the pieces H by two ¼″ lag-screws in each end. On the under side of pieces G and J are cut above and the other below the piece J. Having turned the upper one to the right place, the lower one is firmly screwed up, holding the rod rigidly in place. The top of the rod is split with a hack-saw, each side being opened out ⅜″, to form a U-shaped top. A ⅜″ hole is drilled 1″ from the end, to receive a small bolt which holds the rod N.

The rod N is of bar iron, 13¾″ long, 1″ wide and

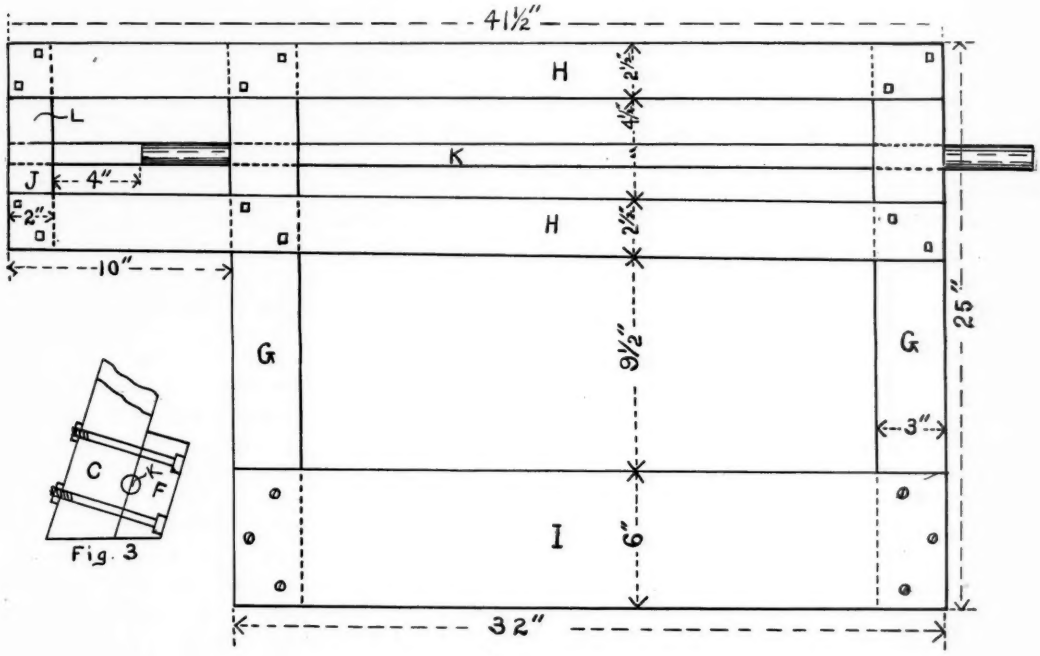


Fig. 3

FIG. 4.

sockets 1½″ square to receive the treadle-shaft, K. This shaft is a piece of steel 1½″ square and 45½″ long. At the right end, for 4″, it is turned down to 1″ diameter, and the same from 6″ to 10″ from the left end, to fit the bearings previously described.

The fitting of this shaft should be left until the frame is completed, so that exact measurements can be taken of the places where it is to be turned down. On the under side of pieces G and J are screwed strips of wood 6″ long and 1″ thick, to hold the treadle to the driving-shaft K. A 1″ hole is bored through J, to receive the round iron rod M. This rod is 15½″ long. The lower end is threaded for 6″ to allow for the two nuts, one ¼″ thick. Holes are drilled in each end, the center of the rear one being ¾″ from the end, and is 7/16″ in diameter. The front one is 1 1/16″ diameter, the center being 1″ from the end. These measurements may have to be changed slightly from those given, to secure correct running of the treadle, but no difficulty will be experienced on that account.

The drive-wheel, O, is made of three layers of matched maple, or birch, each layer being 1⅛″ in thickness. It should be carefully planed and of well-dried stock. The grain of each layer should be crossed and all well glued and screwed together. The diameter of the largest wheel is 18″, the next size 17 1/16″, and the smallest 16⅛″. It can

be completed and mounted and then turned down, thus seeming a perfectly true wheel. A slight crown is given each step, to correspond with that on the cone on head stock. This makes the belt run better. In the center of the outside layer a hole 3″ in diameter is cut through to the next layer, to form a recess for the nut on the bolt P. A 1¼″ hole is bored through all the layers, to receive the bolt and also a bushing of brass tubing, S, ⅛″ thick and 1″ inside diameter. This bushing of brass tubing should fit the hole in the drive-wheel tightly, and can be used to remedy any tendency of the wheel to wabble by trimming out the hole in the wood and shimming up with thin strips of wood secured in place with cement or glue.

The lag-screw, R, is 3″ long and ⅝″ diameter, and is screwed into a hole, the center of which is 2½″ from the center of the bolt P. Any burr around the head should be filed off, so that it will work smoothly in the hole in the rod N. A thin washer should be placed between the rod N and the drive-wheel. The bolt P is 6½″ long and 1″ diameter. It is advisable that this be specially made of smooth steel shafting, to secure a good smooth bearing that will not rapidly wear out the brass bushing. Any machine shop will supply one at small cost. A 1″ collar is set between the piece D and the drive-wheel, and may run loose. The thread on the end of the bolt should go only far enough to receive the nut, which should be screwed up tight to prevent it from turning off. The head of the bolt is sunk into the crosspiece D, and by regulating the depth the head is sunk in, the nut can be brought to just the place where it will not bind and yet stay tight. A piece of sheet steel between the drive-wheel and the nut will prevent the wood from wearing away. Over the head of the bolt, when finally adjusted, screw a piece of wood, T, to the piece D, to hold the bolt in place.

The frame being completed, assembled and any needed adjustments made, the head stock may be placed in position and bolted to the bed. The tail stock is placed on the other end, and each looked over to see if they are correctly lined. A flat belt 1″ wide is then cut and fitted. If the treadle, by reason of its weight, runs unevenly, a hole can be bored at an angle in the rear piece H, and a bolt placed in it and loaded with iron to balance the treadle.

HOW TO BUILD A ROWBOAT.

C. R. Sawyer.

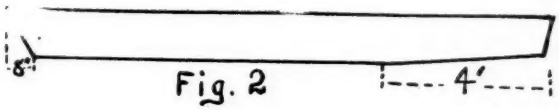
No doubt many of our young friends are looking forward to the coming summer, and some are even planning what they will do. If a boy has a mechanical turn of mind, nothing will give him more enjoyment and satisfaction than to build a boat. The following description will give all the instruction necessary to build a boat 12′ long. All the articles required are ten boards ⅞″ thick and about 14′ long, two boards 14″ wide, ⅞″ thick and 13′ long, free from knots; a piece of oak 2′ 6″ long, 10″ wide and 1″ thick; a piece of oak 2½″ thick, 8″ wide and 16″ long; some galvanized iron nails and some white lead or thick paint.

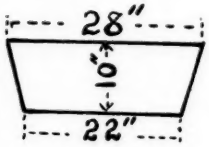
The first thing to make is the stem. Take the piece of oak 16″ long, 8″ wide and 2½″ thick, and cut grooves of the shape shown in Fig. 1. This can be easily done with a backsaw, smoothing over with a rabbet plane, or it may be made of two pieces firmly screwed together.

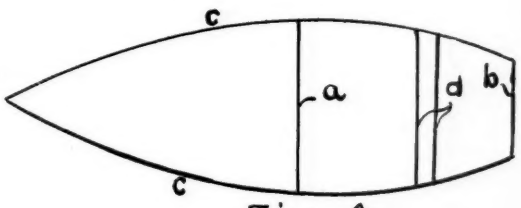
Then proceed with the piece for the stern (Fig. 2), which is made of oak, 1″ thick, 10″ wide, cut slanting on the ends, so that the top measures 28″ and the bottom 22″ long. Make a similar piece of pine for a cross-board, 4′ on the top, 3′ 6″ on the bottom and 1′ wide. For the side boards take the two pieces 14″ wide, which should be of pine or cedar and perfectly sound and free from knots, so they will bend evenly. The ends of the side boards should be sawed off like the cross-board, making it 8″ shorter on the bottom, as shown in Fig. 3, for the bow. Beginning 4′ from the other ends, cut a bevel down to 10″ wide; also bevel on the ends, as shown in Fig. 3. Place the ends of the side boards in the grooves of the stem, have the bottom end of the stem flush with the bottom of the side boards, taking care that the ends fit nicely in the grooves, and screw them securely to the stem with the brass screws. Then place the cross-board about midway between the ends of the two side pieces, with the longest side on the top, as shown in *a*, Fig. 4, and fasten lightly with nails. With the aid of a rope and a stout stick, draw in the ends of the side piece by twisting the rope until they join the stern board shown at *b*, and nail securely. Then carefully turn the boat over and plane the bottom edges of the sidepieces

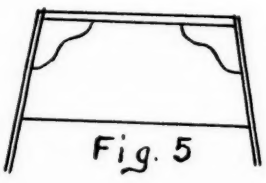
so that the bottom will have a flat and smooth bearing. The bottom boards can now be nailed on. All joints should be coated with lead paint before finally fastening together. A bottom board about 8″ wide and $\frac{7}{8}$″ thick should then be placed nailed temporarily across the top edges, to keep the sides in place until the seats are put in.

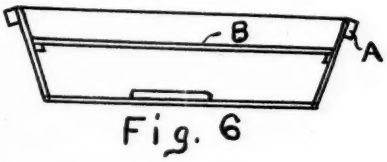
In the stern, about 4″ from the top edge, nail a cleat on each side parallel to the top for the seat. The boards for the seats should be 14″

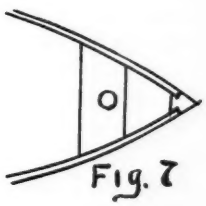


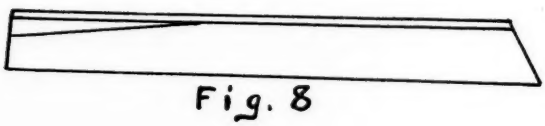


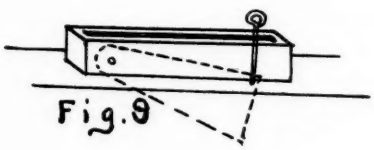


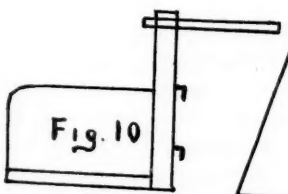


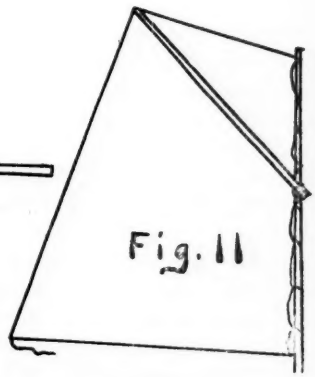












inside, extending the whole length of the boat, to stiffen the bottom. The nails should be driven from the inside, and the ends turned over. Of course the cross-board will have to be removed before you do this. It will be well to put brackets in the corners where the stern board joins the side boards, as in Fig. 5. A piece of wood can be wide. Also put a seat the same distance from the top edge, 5′ from the stern, and another halfway between this and the bow. Fill in the bow of the boat for 2′ from the stem, as shown in Fig. 7. Then fit the two gunwales, $2\frac{1}{2}$″ wide, the entire length of the boat and across the stern, as shown in A, Fig. 6, care being taken in fitting the strips

so as to give a finished appearance to the whole boat. If it is not convenient to secure rowlocks, holes may be bored in the gunwales about 3″ apart and 9″ astern of each seat. The holes should be ⅞″ in diameter, and fitted with oak pins 6″ long, so that when the pins are in they will project about 4″ above the gunwales. It will be preferable to secure rowlocks, as they cost but little and are easily fitted. The boat should have an oak keel, to make the boat row steadier, ⅞″ thick and 2″ deep, reaching from stem to stern, with a triangular piece at the stern, as shown in Fig. 8.

This boat can be made into a sailboat by putting in a centerboard. To do this, make a centerboard box 4′ long, 10″ high and 1″ wide inside, as shown in Fig. 9. Then cut a hole lengthwise in the bottom of the boat 3′ 8″ long and 1″ wide through the bottom keel and inside board, after which screw the box securely in place, after having covered the bottom edges with lead paint. The centerboard box should easily take a ¾″ centerboard. The board can be hinged by a bolt, as shown in Fig. 10. An iron rod should be placed at the other end to raise and lower the board as needed. Make a rudder and tiller as shown in Fig. 11. The rudder should be 17″ long and 12″ wide, with a tiller 15″ long, all made of oak ¾″ thick.

Cut a hole 4″ in diameter 1′ from the bow, as shown in Fig. 7, and put a step in the bottom directly under this hole to support the mast, which should be about 10′ long, 4″ in diameter at the base, tapering slightly to the top. The sail can be made of No. 1 duck, and should be cut as shown in Fig. 12, which will give ample sail for a boat of this kind. All the material for this boat can easily be purchased for about $12. Not including rudder, mast, sail and centerboard, the cost would be about $6.00. Much will depend upon the ability of the one who builds the boat as to what the boat looks like when it is done, but if care is used and the foregoing directions closely followed, you will have a good boat and a fast sailer in smooth water. If not experienced in sailing, however, the sail had best be omitted.

Show AMATEUR WORK to your friends.

THE United States government has decided henceforth to put its trust in electrical alarm devices rather than in bolts and bars and steel safes as means of protecting the public funds from the enterprising and up-to-date burglar. It is well known that by the use of electricity and certain secret compounds known to expert burglars, any vault or safe can be opened in a short time. The solution of this question seems to be in installing electrical alarm systems, whereby it will be impossible for burglars to enter or even make an attempt to disturb vaults without an alarm being given that will instantly call police or other protection. Devices have already been invented and put in use which demonstrate the entire practicability of electrical protection. Not only do they give instantaneous alarm whenever the safes or vaults are tampered with, but they report automatically every minute or two that everything is all right. Even if communication were interrupted so that an alarm could not be given, the fact that the regular automatic report is not received would cause the sending of men instantly to ascertain if there were any trouble.

LIEUT.-COL. R. E. B. CROMPTON, the well-known English electrical engineer, is the author of the following very interesting sketch, published in the London financial paper, *Electrical Investments*:

"On one occasion Dr. Wm. Siemens was lecturing on arc lamps at the Royal Institution, and in those days it was the custom to work lamps with very short arcs. Owing to the fact that it was not appreciated that 45 volts were necessary for arc lamps, makers only allowed 35 volts, so that the lamps were always fizzing and hissing and forming 'mushrooms' or 'cauliflowers' on the negative carbon. Dr. Siemens was lecturing on the arc lamp, when one of these cauliflowers fell off one of his own lamps on to the center of his head — which was bald — and produced a most remarkable effect. I do not think the Royal Institution ever witnessed a more pleasing experiment."

THE German ministers of war and agriculture have offered several prizes, 10,000 marks being the highest, for military automobiles using alcohol fuel.

STUDIES IN ELECTRICITY.

VII. RESISTANCE.

We have now to consider one of the most important laws of electrical science. It is known as Ohm's Law, being first formulated in 1827 by Dr. G. S. Ohm, a German mathematician, and is as follows: "The strength of a current is directly proportional to the electro-motive force and inversely proportional to the resistance."

In the first chapter of these studies the flow of water through pipes was used to illustrate the flow of the electric current. This comparison will again be utilized in studying that property of materials by virtue of which they obstruct the flow of electricity through them, and which is termed "resistance." In the water or gas pipes this obstructing force is known as friction. The reservoirs and standpipes of a water-supply system serve the purpose of giving a pressure adequate to overcoming the friction of long lines of pipe and forcing the water to distant places. A large short pipe will deliver water much faster than a long, small pipe. The higher the reservoir, the greater the pressure on the water-pipes and the faster the flow of the water.

The greater the initial pressure, the stronger is the current of electricity; and also, the greater the resistance, the less the current.

The ohm is the term used to measure and express in definite numbers the comparative resistance of different materials. As adopted by the International Congress of Electricians which met at the Columbian Exposition in 1893, the ohm is "represented by the resistance offered to an unvarying electric current by a column of mercury, at the temperature of melting ice, 14.4521 grammes in mass of a constant cross-sectional area and of the length of 106.3 centimeters." A little easier to remember is the fact that 100 yards of ordinary iron telegraph wire has approximately a resistance of 1 ohm.

The resistance of a conductor depends upon several conditions:

1. Its length.
2. Its cross-section.
3. The material of which it is composed, including the purity and density of such material.
4. The temperature.

To this may be added the resistance due to imperfect contact, but this is more properly a matter of construction than a property of the materials. It is made valuable use of, however, in telephone transmitters and coherers of wireless telegraphy apparatus.

Considering the first of these conditions, we find that the resistance of a conductor is proportional to its length. If the resistance of a certain length of wire is 5 ohms, then the resistance of a wire ten times as long, would be ten times as great, or 50 ohms.

The resistance of conducting wires is inversely proportional to the square of their diameters, or to the area of their cross-sections. A wire $\frac{1}{4}''$ in diameter would conduct four times as well as a wire $\frac{1}{8}''$ in diameter; if of the same length, the larger wire would have only one-quarter the resistance of the smaller one. The necessity of a careful calculation of the capacity and requirements of the wiring for electric plants is evident.

Some materials offer greater resistance to the electric current than others. Silver, copper, aluminum, platinum, iron and lead are the metals most commonly used in electrical work, and are given in the order of relative resistances, the lowest first. Iron offers about six times the resistance of copper. Annealed wire gives less resistance than hard-drawn. An alloy of two metals will have a higher resistance than either alone has. Nearly all pure metals increase their resistance with an increase in temperature at the rate of about .4 per cent for each degree Cent. Carbon is an exception to this rule, the resistance diminishing on heating.

Some materials, having such a high resistance as to be practically nonconductors, are called insulators. Glass, porcelain, marble, slate, mica, shellac, wax, paraffin, hard and soft rubber, various oils and fats are those most commonly used. With these materials the resistance decreases rapidly with the increase in temperature. The

property of resistance is utilized in electrical measurements and in rheostats to regulate the flow of currents to motors. In a rheostat a number of coils of wire are so arranged that, by moving a switch, the resistance is gradually reduced, allowing more of the current to flow till all the resistance is cut out and the full current passes directly to the motor.

The energy of the current in overcoming this resistance is converted into heat. Those who have witnessed a break in a wire carrying an electric current of high potential, such as trolley wire, have seen that, when the broken wire comes in contact with the ground, it soon becomes red hot. This heat is developed by the resistance of the wire. Fires in buildings have been caused by a wire carrying a heavy current becoming "crossed" or in contact with another wire carrying a small current, such as a telephone or bell wire, and causing the latter to become highly heated. Hence the necessity of protecting all wiring from an excessive current. This is commonly done by interposing, at some suitable place in the wiring, a short length of metal similar to solder called a "fuse," which melts at the maximum temperature the circuit is capable of sustaining without danger. The melting of the fuse breaks the circuit, thus preventing the flow of the current. In electric welding and heating the resistance is so arranged as to heat the metal to the required degree.

This property of resistance is also important in considering the composition of batteries, and also upon their arrangement or grouping. The metals and chemicals that are used in the various cells differ greatly in the potential force they produce, and likewise in the resistance they offer to the flow of the current. A comprehensive consideration of chemical composition of cells requires a considerable knowledge of chemistry, and is outside the scope of these studies. A separate article on "Batteries," soon to be published in this magazine, will describe the more common types in use and the properties peculiar to each. A brief statement of the general characteristics of all cells is desirable at this time, to enable a proper summary of this and the previous chapters.

A cell is commonly composed of two metals of different potentials which are acted upon by an acid. A current flows when, by means of a wire or other substance, a complete circuit is established. The force of a current is termed the electromotive force (abbreviated E. M. F., or E.), and is expressed in *volts*. As applied to batteries, this difference of potential or pressure or voltage is dependent upon what metals are used rather than on their size. The greater the difference in the tendency of the metals to combine chemically with the acid, the greater the E. M. F.

The *anode* is the metal in the cell by which the current enters and which is dissolved during the action of the cell. The *kathode* is the metal by which the current leaves the cell, which remains constant or receives a deposit of some residium of the chemical action of the cell. These two terms have other applications analogous to these, which will be considered in the appropriate place.

The E. M. F. produced by a cell is rarely the exact difference in potential of the metals composing it. This is due to the resistance which the current meets and overcomes, mostly in the liquids of the cell. This resistance may be reduced by using larger pieces of metal or placing them nearer together. It is increased by the continued action of the cell, which causes a change in the chemical composition of the liquids, and also generates gases which attach to the surface of one of the metals, reducing the surface which may be acted upon. This is termed "polarization."

These chemical changes continue so long as the current flows, and are proportional to the volume of the current flowing.

With the information which has been presented in this and previous studies clearly in the mind, the relations existing between the E. M. F., resistance and current flow should be evident, and, knowing any two of these factors, the other can be found. Briefly, the E. M. F. (volts) divided by the resistance (ohms) will give the current (amperes).

The current (amperes) multiplied by the resistance (ohms) will give the E. M. F. (volts).

The E. M. F. (volts) divided by the current (amperes) will give the resistance (ohms).

These fundamental laws of electrical work should be studied until thoroughly memorized and understood, as this will do much to simplify many features of electrical study hereafter to be presented.

THE CONSTRUCTION OF A SMALL STORAGE CELL.

H. F. SHEPHERD.

THE accompanying sketches and description apply to a small storage cell which has been found to give excellent results in practice. One of these cells, built by the writer, has been used for igniting the charge of a gas engine, and had a capacity of a trifle over 2 volts and about 12 amperes. For the construction of the cell there are required about 1½ sq. ft. of sheet lead $\frac{1}{16}''$ thick; 1 lb. of red lead; 1 lb. of yellow lead or litharge; 1 lb. of sulphuric acid; 6″ of lead wire ¼″ in diameter; two brass nuts, and a binding post.

The outside shell of the cell is of sheet lead, and forms part of the negative electrode. This is made by cutting out of the lead sheet a piece $9\frac{5}{8}''$ wide in one direction, and 6″ wide in the other, with a lug or ear at one corner 2″ long and 1″ wide, as shown by Fig. 1. This is rolled into the form of a cylinder 3″ in external diameter, which will give a lap of about $\frac{3}{16}''$. The edge that is 6″ wide should lap on the outside of the edge 8″ wide, and the joint should be soldered, taking care not to fuse the lead any more than is absolutely necessary.

The bottom of the cell consists of a disc 3″ in diameter, to which the edges of one end of the cylinder should be fitted rather carefully and soldered. Next cut out a sheet of lead 5½″ by 8″, and punch this full of holes not larger than ¼″ in diameter, and as close together as possible without making the lead so weak that it cannot be safely handled. The holes can be cut with an ordinary belt punch. This perforated sheet should be rolled into a cylinder 2½″ in outside diameter and 5″ long, the lap being soldered in three or four places, but not necessarily throughout its length.

This cylinder should be set inside the first cylinder so as to leave an annular space of $\frac{3}{16}''$ uniform width between it and the interior wall of the main cup. This annular space should be filled with a paste made of litharge or yellow lead and dilute sulphuric acid, the acid being diluted by mixing it with ten times its weight of water. After packing the paste into position, let it dry thoroughly. The struoture thus far obtained constitutes the negative plate of the cell.

Next take the piece of ¼″ lead wire, thread it through a countersunk hole in the center of a wooden disc $2\frac{5}{16}''$ in diameter and ½″ thick, beating a burr on the end of the lead wire which will fill the countersink in the wooden disc, as indicated in Fig. 2. This disc must be thoroughly boiled in paraffin. Then cut out ten lead discs, 2¼″ in diameter, and drill a hole ¼″ in diameter in the center of each disc. Flute the edges of each disc with a pair of pincers, so as to convert each one into a very shallow dish, as indicated by Fig. 3, and punch the bottoms of these dishes full of holes not over $\frac{3}{16}''$ in diameter. Thread the first dish on the wire, letting it rest on the shoulder of the wooden disc, and fill it with a paste made of red lead and dilute sulphuric acid. Next thread another dish on the lead wire, taking care not to push it entirely down on top of the first dish, and fill it also with red lead paste.

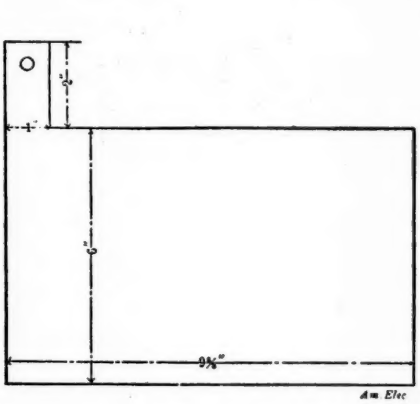


FIG. 1.

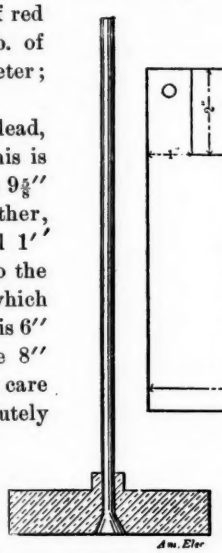


FIG. 2.

It will be found a good plan to set two strips rubber or thoroughly dry wood across the top

of the first dish for the second dish to rest on until its paste has hardened. The holes in the center of the dishes should be a tight fit on the lead wire, so that the friction there will tend to prevent the dishes from slipping down. The succeeding dishes are slipped on the wire and filled with paste one by one, until the whole ten are in position, and the cell may then be assembled, as shown by the cross-sectional view (Fig. 4), the electrolyte being put in before the cover is put on, of course. The electrolyte consists of dilute sulphuric acid, the hole and attacking the brass nuts on the outside.

The binding post should be of the wood-screw variety, and its screw should not be long enough to go entirely through the cover. The ear, 1″ by 2″, shown in Fig. 1, is bent over on top of the cover, and the binding post passed through the hole in the ear, the post being screwed down hard on the ear to form connection with the outer shell. The cover must have a venthole about $\frac{1}{16}$″ in diameter, in order to allow the escape of liberated

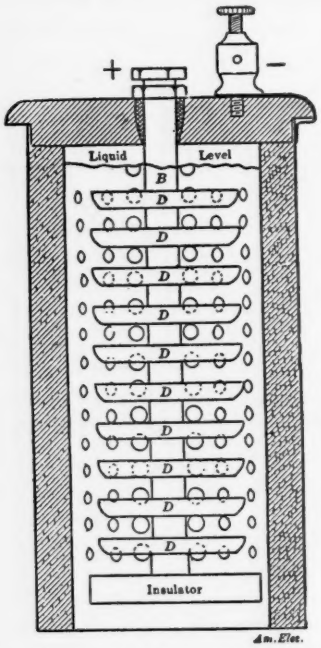


FIG. 4.—CROSS SECTIONAL VIEW OF STORAGE CELL.

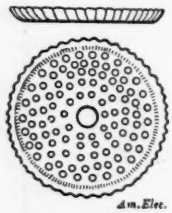


FIG. 3.—LEAD DISHES PUNCHED WITH 3-16THS IN. HOLES.

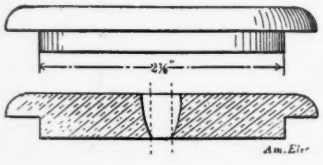


FIG. 5.—COVER.

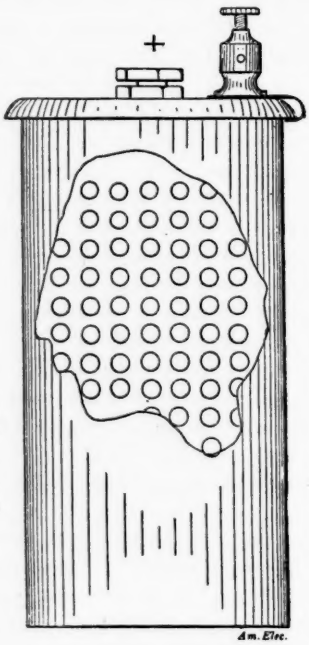


FIG. 6.—STORAGE CELL COMPLETE.

exactly like that used in mixing the paste, and the level should be well above the topmost dish.

The cover of the cell may be made of hard wood or of rubber, preferably the latter, and should be of the shape shown by Figs. 4 and 5, the lower part of the cover fitting snugly the interior diameter of the outer lead shell. If the cover is made of hard wood it must be boiled in paraffin. The hole in the center of the cover, through which the lead wire passes, should be tapered, as indicated in Fig. 5, and filled with coal tar or pitch, so as to prevent the acid fumes from passing up through gases. Fig. 6 shows the cell with the outer shell and the litharge paste cut away to reveal the perforated inner shell.— *American Electrician.*

REAR-ADMIRAL BRADFORD, chief of the Bureau of Equipment, is investigating, through his agents abroad, all the systems of wireless telegraphy of any merit, with a view of ultimate adoption of one of them for the use of the navy. Thus it is to be presumed that the ships-of-war of the United States will have the best system.

EVERY MAN HIS OWN WEATHER PROPHET.

Prof. Willis L. Moore, the chief of the Weather Bureau, in a recent address, published in the *Marine Review*, says:

"Any intelligent person, by studying the few simple principles on which the daily weather-map is founded, can make an intelligent estimate of the general character of the weather for his region, one, two, and at times, three days in advance.

"You may ask: Why has not this been done by the laymen, whose crops, whose perishable produce in transit, whose vessels exposed to the fury of wave and tempest, and whose health and pleasure are so dependent upon the weather and upon the sequence in which weather changes occur? In answer it may be said that many members of commercial associations, knowing the fluctuations in value of soil products that often result when rain falls on a parched district, when frost smites the corn in the milk, when hot south winds wither the crops in the great central valleys, or when clouds and moisture affect the condition of cotton, make a fairly accurate forecast of the weather from the large daily weather-maps displayed on blackboards before all the important commercial exchanges of the country, and in a pecuniary way largely profit therefrom. . . .

"By preserving the weather-charts each day and noting the movements of the highs and the lows, any intelligent person can make a fairly accurate forecast for himself, always remembering that the 'lows,' as they drift toward him from the west, will bring warmer weather and sometimes rain or snow; and that as they pass his place of observation, the 'highs' following in the tracks of the 'lows' will bring cooler and probably fair weather.

"He can closely forecast the temperature for his region by remembering that the weather will be cool so long as the center of the predominating high, i. e., the high enclosing the greatest area within the 30-inch isobar, is north of his latitude — either northeast or northwest; and that it will be warm so long as the high is south of his latitude. . . .

"To get a rough idea of the difference between storms, we might classify them according to the diameter of the gyrating masses of air under their influence, as follows:

"Cyclones, 1,000 to 2,000 miles; hurricanes, 100 to 500 miles, and tornadoes, 100 to 1,000 feet. We might imagine their vortical action and their destructive force to increase in some ratio as their diameters of rotation decrease.

"The tornado is always an incident and a sporadic outbreak of the cyclone, and usually occurs in the southeast quadrant of a cyclonic storm.

"The thunderstorm, instead of rotating about a vertical axis, like the cyclone and tornado, has a horizontal roll, caused by cold and heavy air from above breaking through into a lighter and superheated stratum next to the earth. This rolling motion throws forward the cool air in the direction in which the cloud is moving. In general, thunderstorms move from the west toward some eastern point, the same as tornadoes, which mostly move from the southwest toward the northeast. If any part of the horizontally rolling air in the thunderstrom drops down toward the earth and adjusts its rotation about a vertical axis it at once becomes a tornado, and its destructive force is increased a hundredfold.

"Large owners of marine property estimate that one severe storm traversing our Atlantic coast in the absence of danger warnings would leave not less than $3,000,000 worth of wreckage. On two occasions a census was taken immediately after the passage of severe hurricanes, to determine the value of property held in port by the danger warnings sent out in advance of the storms. In one case the figure was placed at $34,000,000, in the other at $38,000,000. Of course this does not represent the value of property saved. It simply shows the value of property placed in positions of safety as a result of the danger-signals displayed and the warning messages sent to vessel masters."

Consul Haynes of Rouen, under date of Aug. 26, 1901, says that the metric system is to-day compulsory in twenty countries, representing in all more than 300,000,000 inhabitants,— Germany, Austria-Hungary, Belgium, Spain, France, Greece, Italy, Netherlands, Portugal, Roumania, Servia, Norway, Sweden, Switzerland, Argentine Republic, Brazil, Chile, Mexico, Peru and Venezuela,— and advises American exporters in dealing with any of these countries to adopt the system.

AMATEUR WORK

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MAY, 1902

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IN the June number will appear the first chapter of a complete description of how to make a wireless telegraphy apparatus. All the different parts will be fully described, so that any one desiring to make an outfit will have no difficulty in doing it. The item of cost has been carefully considered, and the expense will be the least at which workable instruments can be made. The same writer will also contribute articles on the making and operating of X-ray apparatus, and other instruments of interest to those engaged in electrical experimental work.

NUMEROUS inquiries from our readers regarding directions for making an automobile at low cost lead us to request contributions on this subject. Any reader who has constructed a serviceable automobile at a cost of not over $100, and can give a clear and comprehensive description of how it was done, together with the necessary sketches, is requested to communicate with the editor in reference to contributing such a description for publication in this magazine. Such descriptions are desired for vehicles using steam and gasoline motor power, but must not be too complicated in design. If suitable arrangements can be made, such descriptive articles will be published with the expectation that many of our readers will utilize the information in constructing a carriage.

OUR readers are invited to contribute to the correspondence column their experiences in making things described in this magazine. Many valuable suggestions would be obtained in this way which would be helpful to all.

THE tables intended as a part of this month's chapter of Mechanical Drawing are omitted, but will appear in the next number.

IT is reported from Vienna that a resident of that place, named August Matitsch, has devised a lace-making machine, which is said to produce lace which is indistinguishable from the hand-made article.

MECHANICAL DRAWING.

Earnest T. Childs.

VII. THE ASSEMBLY.

The amateur who has closely followed these talks on mechanical drawing, and who has applied himself sufficiently to have completed reproductions of the specimen drawings which have been shown, will have attained by this time a fair knowledge of what is required of the mechanical draughtsman as a copyist. By this is meant that he will have learned the necessary details which must be acquired in order that he may draw lines correctly on tracing cloth or paper, at the same time working from some predetermined outline or dimensions. This is the first step in the development of the mechanical draughtsman, and is extremely important. A person capable of making accurate copies with reasonable celerity has the foundation upon which the future draughtsman may stand. Without doubt accuracy is most important, but rapidity follows a close second. The ability to make free-hand sketches in a clear, concise manner, as described in the last chapter, is also a valuable requisite.

All the above requirements are, however, those of the copyist only, and it is on this basis that the young draughtsman generally starts his work in the drawing-office. As his ability to comprehend increases by practice in copying or tracing, and as he profits by his observation of work with which he comes in contact, just so fast will he advance. Once started in the work, it depends upon himself alone just how fast and how far he will be able to go.

There are other things required, however, for the production of the first-class mechanical draughtsman. He must be well posted on engineering subjects, must understand the principles of mechanics, must know about the strength of materials, and must have a working knowledge of steam and electricity, not to mention a dozen other kindred subjects.

These requirements are enumerated, not to discourage the student, but rather to direct the course of his study into the proper channels. The draughting board is not a thing to which every draughtsman expects to be tied throughout his natural life. It may be looked upon as a stepping-stone to something broader and higher. And it is an extremely essential stepping-stone. It would surprise many, if statistics were available, as to the number of superintendents and chief engineers who started their careers over the drawing-table.

But aside from the future possibilities of the man who actually works over the board in the drawing-office, a thorough knowledge of drawing is of vast importance to every artisan, no matter whether he be journeyman or apprentice. Let us consider for a moment a few of the trades in which a knowledge of and an ability to read plans will be absolutely necessary. Imagine, if possible, a machinist starting to build an engine without plans to work from, or a patternmaker making a pattern for a cylinder by guesswork. The result may be a thing which will run, but it can be obtained only by a cut and try process, and when the machine is complete there will be no record to show what it is like. The same will apply to a motor or any other piece of mechanism. Ask a carpenter to build a house, and the first thing he does is to make a plan, even though the house be only a beach cottage. A mason must be able to read plans to lay out foundations, walls, etc. A plumber or a steam-fitter always makes a diagram before piping a job.

In fact, there is hardly a trade where a knowledge of drawing will not be useful to the workman, and it is more particularly to help the apprentice and the young journeyman that these talks have been given. If a young man is anxious and ambitious to become something more than an ordinary workman, the first step will be to learn to read drawings, and this will be succeeded by courses of study along the lines of his chosen occupation.

This chapter will close the present series of articles on mechanical drawing, and the assembly drawing of the engine, together with the last details, are given herewith. It has been necessary to draw the assembly to a very small scale ($1\frac{1}{2}'' = 1'$) on account of the size of the sheet; but

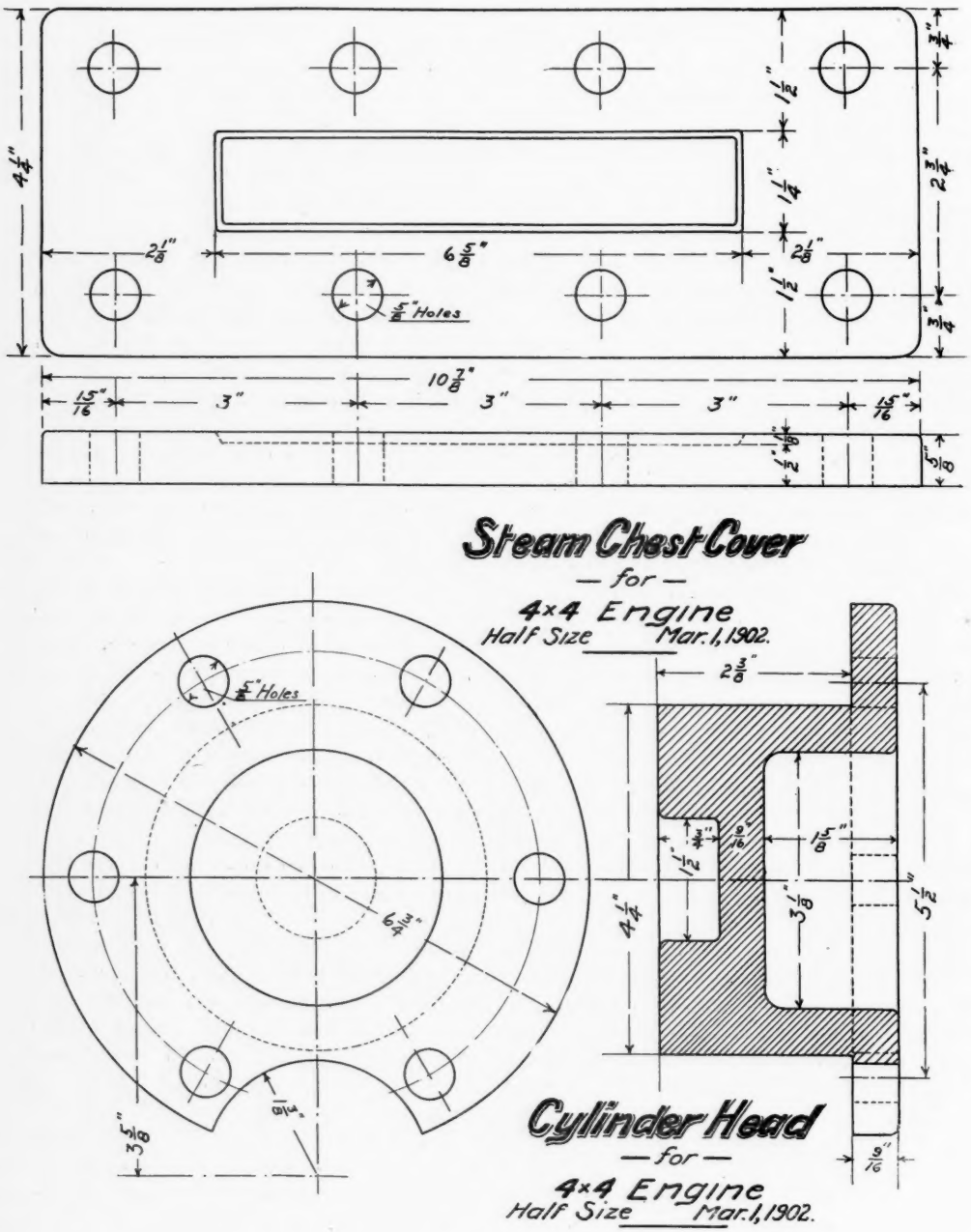

Steam Chest Cover
— for —
4×4 Engine
Half Size
Mar. 1, 1902.
Cylinder Head
— for —
4×4 Engine
Half Size
Mar. 1, 1902.

FIG. 22.

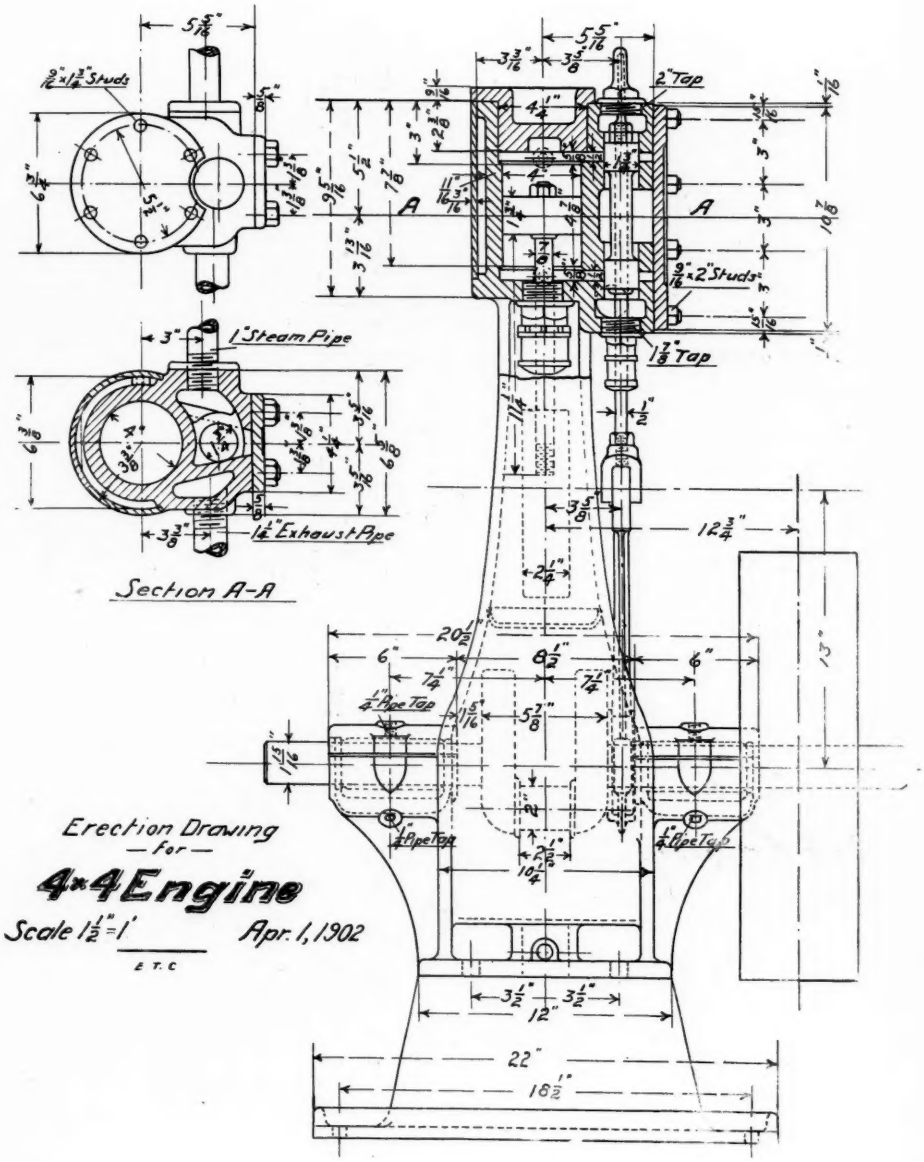

Section A-A
Erection Drawing
— for —
4×4 Engine
Scale 1½"=1'
Apr. 1, 1902
E. T. C.

FIG. 23.

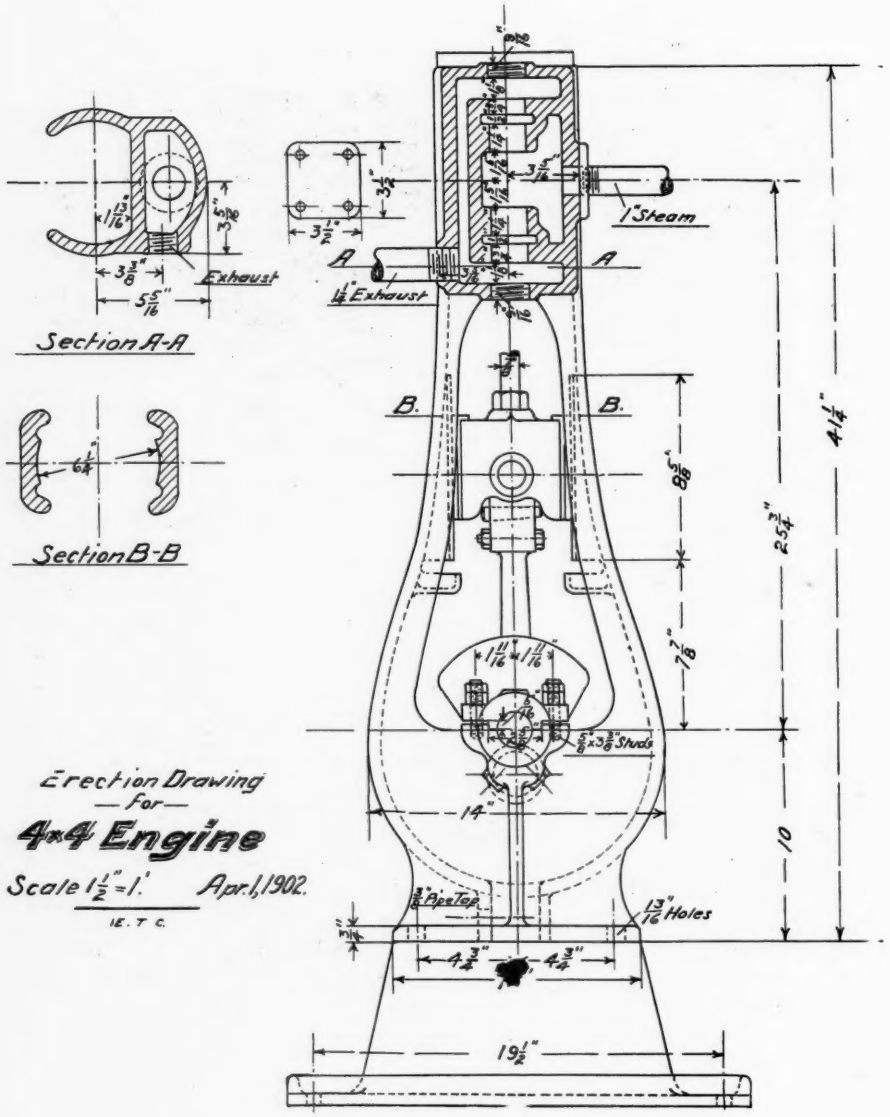

Section A-A
Exhaust
Section B-B
Erection Drawing
— for —
4×4 Engine
Scale 1½"=1'
Apr. 1, 1902.
I.E.T.C.
Steam
Exhaust
A
B.
14"
Holes
Studs
41¼"
25¾"
10
19½"

FIG. 24.

in redrawing, this should be enlarged to half size in order to better show the various details. Particular attention should be paid to the choice of sections of the engine to full scale. There is little to be said regarding the sheet showing the cylinder head and steam chest. These are necessary to complete the final details of the engine. It will be seen that in this course we have drawn every detail of this 4 x 4 engine, and the complete work is attained in the assembly drawings.

Incidental to the acquisition of a knowledge of mechanical drawing, it has been possible to obtain also a small idea of the drawing required for the parts which go to make up a small upright engine. This series will not be complete, however, without a little additional data. In Chapter III is given an outline of the various common types of screw threads. The United States standard screw thread is one with which all draughtsmen should be familiar. This thread is slightly flattened at the apex, and the angle is 60°. The standard dimensions of threads from $\frac{1}{4}''$ to 2″ are given in the accompanying table (see Table No. 1) and the load which each will hold is given, based on a tensile strength of 5,000 lbs. per square inch of cross-section. It will be observed that the rough iron sizes vary slightly from the standard, the latter being smaller, due to the flattening of the V to prevent injury to the thread.

Supplementing the data on screw threads, it is essential that one should possess some knowledge of nuts and boltheads. With this in mind, a table has been made giving the most important dimensions for hexagonal nuts, in sizes from $\frac{1}{4}''$ to 2″ in diameter. (See Table 2.)

In connection with these tables it will be found convenient to have one giving decimal equivalents of fractions of an inch. (Table 3.) These tables will do to start a reference notebook, which every draughtsman should have and should add to it the scraps of information secured from time to time. The best kind of a book for handy reference is one which is indexed, thus making it possible to classify the information the more readily. Later, when the notebook may become overcrowded, the information may be transferred to a card index, alphabetically arranged. This is, however, rather beyond the range of the present subject, and is given as a hint for future work. Part II, Projection, will be the subject of continued talks.

DETAILS of a contract between Signor Marconi and the Canadian government, by virtue of which the Canadians have been promised a new transatlantic telegraphic rate of 10 cents a word for ordinary messages, with a press rate of 5 cents a word, have just been made public. The Canadian government will contribute $80,000 toward the erection of a Marconi station in Nova Scotia, according to the plans and specifications made by Marconi himself. Should the station cost more than that amount, the additional expenditure will be borne by the company. It is agreed that there is to be no discrimination on Marconi's part in favor of the United States.

M. L. CAILLETET has presented to the French Academy of Sciences a process for frosting and engraving on glass and crystal by the use of gelatine. The process consists of simply painting on a strong, hot solution of glue, which is allowed to dry. As it drys, it contracts, and the adhesion of the glue to the surface of the glass is sufficiently strong to tear off layers of the surface, leaving a beautifully frosted design. By a mixture of 6 per cent or less of potash, alum or various other crystalline chemicals, very beautiful crystalline patterns are obtained.—*L'Industrie Electrique.*

A STEAMSHIP using oil for fuel recently made a voyage from Borneo to Great Britain, a distance of eleven thousand miles, in splendid time, and at a reduced cost of handling. Three firemen did the work of twenty, with less discomfort and more efficiency. This has practically demonstrated the utility of fluid fuel, and now three oil depots are to be erected at Dover in the English Channel. Like facilities are to be strung along the sea lines of other coasts where ocean travel has its established highways. It takes but three hours for a liner to load up 1,500 tons of oil-fuel, and this and other economies will count in its favor for marine purposes. Will King Coal yet have a royal competitor, or did nature make a mistake in providing "gushers"? A steamship recently loaded 157,871 cases, each case containing ten gallons of refined petroleum, for Japan. The value of the cargo was estimated at $146,000. The United States is building up a splendid foreign trade in this line.—*Age of Steel.*

PHOTOGRAPHY.

INTENSIFICATION AND REDUCTION.

The conditions under which photographic plates are exposed and developed vary so greatly that rarely is it possible to secure a perfectly satisfactory negative. Some will be thin in opacity, with contrasts so weak that the prints made therefrom will be soft and flat, the remedy for which is Intensification. Or the negative may have the reverse of these faults: have too great opacity, or give excessive contrasts, for which the remedy is Reduction. The former faults usually result from over-exposure and under-development; the latter from under-exposure and over-development, or the use of a developer which worked too rapidly, producing opacity without detail.

In Intensification the object sought is to increase the opacity in such a way as to give deeper and sharper contrasts in the print without the loss of detail, and should immediately follow development when possible. Old negatives can be successfully treated, however, and are good subjects for study in learning this work. Having decided that it is desirable to intensify a negative, the first thing necessary is to give it a thorough washing, whether it be old or newly made. It is absolutely necessary to good results that all "hypo" and other free chemicals be completely removed; also that the negative has been properly fixed. If any uncertainty exists on this point it is advisable to refix in a fresh fixing solution; previous to which the negative, if an old one, should be soaked in water for a few minutes, to soften the film. After fixing, again wash in running water until all traces of hypo are removed. A half hour will be none too long a time for this washing.

There are numerous formulas for accomplishing the desired result, but the one here given is reliable, and will give a good insight into the process, and enable other formulas to be tried when desired. The first part of the work consists in bleaching the negative, which is done with a saturated solution of mercuric chloride (corrosive sublimate, *Poison*). In warm weather, or if the negative does not require to be much intensified, the strength of the solution may be reduced. A few trials will soon enable the worker to determine the most suitable strength to be used. In bleaching, the film will gradually whiten, and this should be continued until the under side of the film is affected. When bleaching has been carried far enough, the negative should be well washed in cooled boiled or distilled water, remaining in the last change of water for a few minutes soaking. When washed, the film is again blackened by immersing in a solution made as follows: To five ounces of a saturated solution of potassium oxalate, to which has been added a few drops of oxalic acid, add one ounce of a saturated solution of ferrous sulphate, and then add three ounces of distilled water. This solution gives considerable density, and has the advantage that it may be repeated if desirable to do so.

Those who do not care to prepare their own solutions may purchase of photographic supply dealers prepared solutions for this work, which will give good results and improve many a negative that would otherwise be of but little value.

After the process has become familiar, it may be utilized for improving parts of a negative by local application with a soft brush. Considerable skill is required, however, to do this satisfactorily.

Reduction is the reverse of the above process. Here the desire is to remove the surplus density, to render the contrasts more subdued and bring out detail. It is especially valuable for lantern slides and for clearing foggy negatives. In this work, with the formula given below, hypo is very objectionable, and the preliminary washing to remove it must not be omitted. If reduction immediately follows development, which is desirable, as the film is then well moistened, the washing should be thorough enough to remove all traces of hypo. If it be an old negative, it should be soaked in water until the film is thoroughly moist, and all hypo removed.

The reducing agent recommended to amateur photographers, and especially the beginner, is a three per cent solution of persulphate of ammonium, or say fifteen grains to each ounce of water. When reduction has been carried to the desired

point, the plate is rinsed in water and then immersed for a short time in a ten per cent solution of sulphite of soda, followed by a good washing.

This reducer has the peculiar property of working more rapidly on the denser portions of the plate than on the thinner parts, just what is usually desired. With it clouds, draperies and similar details that are often lost, can be restored, greatly enhancing the printing qualities of a plate.

As persulphate of ammonium is quite unstable, it should be prepared only a short time before use, and worked under a subdued light. There are other formulas which have their special uses, a knowledge of which is desirable as progress is made. It will need but little experience to show their value to the photographer who is desirous of producing good work, and willing to do some experimenting to achieve it.

WATER FOR PHOTOGRAPHY.

In photographic formulas, and many of the processes, the requirement of pure or distilled water is general. To secure good results, it is absolutely necessary that this condition be observed; and it easily may be, if the following directions are observed.

The best water is that which has been distilled and bottled as soon as cool enough. Some druggists will supply this at a very moderate cost, but in purchasing such water make sure that it has not been exposed to the air, so that it has again absorbed oxygen. With some chemicals, the oxygen in the water will cause oxidization that will be harmful. Hence the necessity of keeping the water used in making up solutions in full bottles, well corked. A few bottles of various sizes will enable this to be done without excessive trouble.

If distilled water is not available, rain water collected in porcelain or glass vessels may be used. It should be collected in an open space, after sufficient rain has fallen to clean the air, and not from the roof of the building or water-spout, for such water contains dust and other impurities. It should then be boiled for at least ten minutes in an earthenware vessel, to expel all the air, and bottled when cool enough to avoid breaking the bottles.

At times the weather bureau may not provide an opportune rain, and resort must be had to other sources. If the regular water supply is not too "hard," that is, has in solution much lime or other mineral impurities, it may be used after boiling and bottling, as above directed.

Bottling should follow boiling as soon as possible, as the water, if left in an open vessel, soon absorbs oxygen in considerable quantity.

PHOTOGRAPHIC SCALES.

The photographer who does his own developing and printing has frequent use for a pair of scales. Following is the description of how a very serviceable pair can easily be made at slight expense.

For the stand is required a piece of hard wood 10″ long, 7″ wide, and $\frac{7}{8}$″ thick. In the center of one side cut a socket 2″ long and 1″ deep, to which fit an upright piece 12″ long, 2″ wide and 1″ thick. One inch from the top of the upright drive a stout wire nail, leaving about $\frac{1}{2}$″ protruding, upon which to hang the arms of the scales. With a file, sharpen the upper side of the nail to a knife-edge, to prevent friction and secure a finer adjustment.

About 36″ of galvanized iron telegraph wire or steel wire will be needed for the arms. In the center make a $\frac{1}{2}$″ loop by bending around a bolt or large nail. Then bend the wire downward on each end at points 6″ each side of the center of the loop. Again bend each end outward 9″ from the first bends. On these projections, which will be a little over 2″ long, solder the tops of tin spice boxes. These should be of the same size and weight. If soldering is not convenient, the wire may be a little longer, and two circles made at the ends, upon which the spice-box tops or porcelain plates can rest.

When the bending is completed, file a nick in loop where it rests on the nail, to keep the arms in the same relative position. Then place the arms on the nail and bend them until they hang evenly. It may be necessary to add a little solder on the under side of one of the pans to get a correct balance. For weights, cut a piece of solder or lead into different sized pieces, and with a file and the assistance of a set of correct weights adjust until they are correct. For the smallest weights pieces of tin will be handier to handle.

A SUNDIAL.

In these days of church clocks and dollar watches a sundial may not be necessary as a means of learning the time of day, but as an ornament for the lawn and as a reminder of days long past it serves a useful purpose. The following directions will enable any one to make a sundial that will give fairly correct sun time, which differs in most places from standard time.

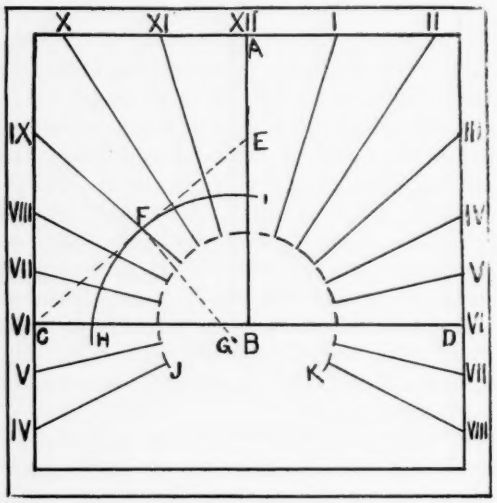


Fig. 1.

For the base, procure a piece of well-dried wood 13½″ square and ⅞″ thick. This should be planed perfectly smooth, with a small bevel around the edge of the upper side; mark with a sharp point a line around each side of the top ¾″ from the edge. This will give a square measuring a foot on each side. Four inches from the bottom side draw the line C-D for the six o'clock time (see Fig. 1). From the centers of this line and the top line draw the line A-B. Then draw the line C-E at an angle corresponding to the latitude of the place where the dial is to be erected. This angle is also used in making the gnomon. Divide the line C-E in the center and at a right angle to it draw the line F-G, which is one-half the length of the line C-E. Using the point G as the center and the line F-G as the radius, describe the arc H-I. Divide this arc from the points where it crosses the lines C-D and A-B into six equal parts, marking lightly each division. From the point B draw lines through these divisions to the lines along the edges, omitting them for a space of about three inches around the point B. These are the hour lines, and both sides of the dial are alike, one side being taken from the other. The lines below the six o'clock line, C-D, are but continuations of the opposite lines above.

The gnomon is the projection above the face of the dial which casts the shadow. (See Fig. 2.) Preferably it is made of stiff sheet brass, which may be polished to increase the ornamental effect. If made of wood, the grain should run perpendicularly and the hour markings on each side should be separated by a space equal to the thickness of the wood. The line A-C is at an angle with the line A-B corresponding to the latitude, as before mentioned. This upper edge is called the style; the base is the substyle. A piece of brass or wood 8″ square is required for the gnomon. The base, A-B, is 8″ long. The angle of the line A-C determines the height of the side B-C. If of brass, two projections, D and E, are left on each end of the base. These are 1″ square, the pieces D being bent to one side and the pieces E to the other. A hole is bored in each piece to receive a round-headed brass screw with which to hold the gnomon firmly erect.

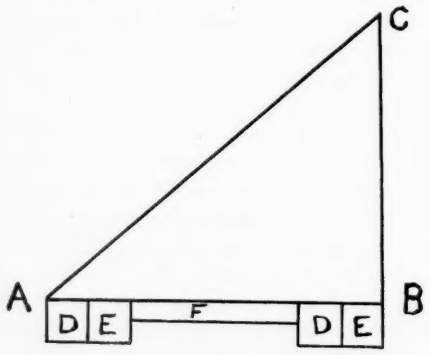


Fig. 2.

If of wood, leave an extension, F, ½″ deep, which should be well fitted to a socket cut in the base-board, centering on the line A-B. It may be held in place by wire nails, carefully driven from the under side to avoid splitting. When the gnomon is fitted, the base should be well oiled with linseed oil and then painted with two coats of outside

white paint. A tube of black paint and a small brush are required for marking the hour lines, which should be about $\frac{1}{8}''$ wide. First paint the bevel of the edges, then the lines marking the square, then the hour lines. The letters giving the hours complete the marking.

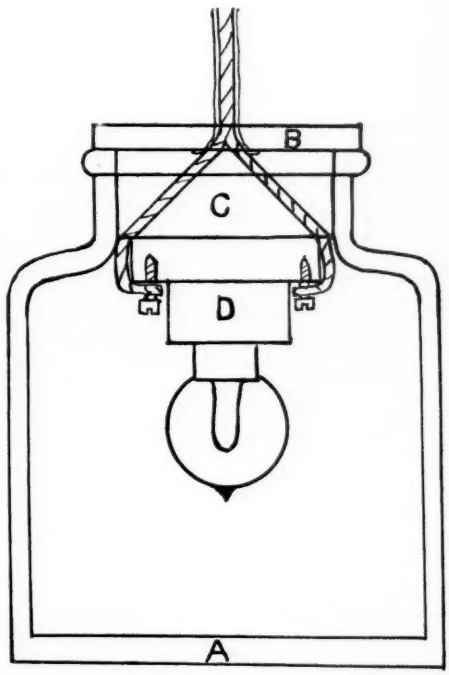
The dial is erected on a firm post and should be perfectly level, with the gnomon or line A-B pointing due north. A compass or the north star may be used to set the dial. If the post is ornamental, it will add to the general appearance.

FISHING BY ELECTRIC LIGHT.

THE electric light equipment here described will add much to the interest, and, if the fish are in the right mood, to the length of the string of an evening's fishing. The necessary materials are: a small incandescent electric globe and porcelain base of about three-candle power and three volts; a dry battery for same, of the kind used in bicycle or night lamps; several yards of two-way flexible covered wire of small diameter, some rubber tubing to cover the flexible wire, a glass bottle with large mouth, and rubber cement.

The neck of the bottle should be large enough to easily admit the porcelain base. Cut a circular piece of wood, B, from a cigar box, large enough to cover the top of the bottle, and in the center bore a hole to admit the rubber tubing with a tight fit. The porcelain base, D, is screwed to the cork, C, with two screws which should be long enough to reach into the wooden piece B. The flexible wire is then covered with the rubber tubing. An easy way to do this is to take a nail which will easily pass through the tubing, tie to it a strong thread, and from an upper window lower the nail into the tubing until it comes out the other end. With the thread, a string is then pulled through, and with the string, the wire in the same way. Firmly attach the string to the wire without any large knots, and also see that the ends of the wire are not likely to catch on the tubing. The wire on the lamp-end should extend about three inches to allow for connections in the bottle.

Through the cork, bore two holes from the center of the top side to the edges of the porcelain base. The wire and tubing are then put through the hole in the wooden piece B, the end of the tubing being attached with bicycle or other cement to the underside of this piece. The two strands of the wire are then put through the holes in the cork and connected with the terminals of the lamp. The upper side of the cork is then covered with cement and pressed firmly against the piece B. When dry, the water will not reach the wire when the cork has been inserted in the bottle.

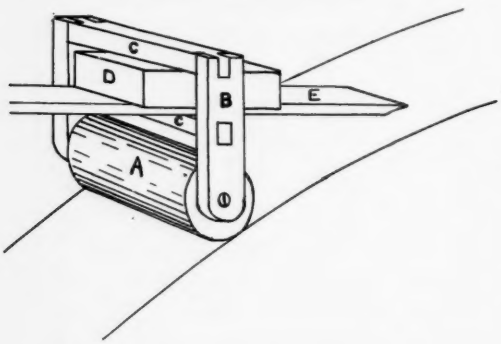


The other ends of the wire are, when ready to use, connected to the battery, and the lamp will then light. The battery is kept in the boat. The wire not in the water does not require to be covered with tubing. In use, the bottle is weighted so that it will sink to the required depth. The battery is then connected to light the lamp. The light will attract many kinds of fish. The fisher and a properly baited line will do the rest.

THE wave motion of the sea is utilized to run an electric-lighted buoy at the mouth of the river Elbe in the North Sea. The least motion of the water is sufficient to generate the electric current, which when not needed passes to storage batteries.

HOLDER FOR GRINDING TOOLS.

THE little devices shown in the accompanying illustration will be found of much assistance when grinding chisels, planes and similar tools. This holder keeps the tools always at the same angle, and also assists in keeping them even, so that the edges may be ground square. It is easily made, as follows: The roller consists of a spool or piece of round, hard wood, 2½″ long and 1¼″ to 1½″ diameter. Two upright pieces, B, are 2¾″ long, ¾″ wide and ½″ thick, the lower ends being rounded. Two pieces, C, are 3½″ long, ¾″ wide and ⅜″ thick, the ends being fitted to mortises in the pieces B, as shown. These pieces are ¾″ apart. Holes are made in the lower ends of the pieces B, for the bearings of the roller. If



a spool is used for the roller, a wooden skewer well smoothed with sandpaper and fitting loosely will answer. If a solid piece of wood, the exact center of each end must be marked, and holes made for screws, which serve as the bearings.

In using this holder, the chisel or other tool is placed between the pieces C, and temporarily fastened with a wedge, D. This wedge may be placed above or below the tool as desired, for the angle at which the tool is to be ground. The angle is also regulated by the distance the tool projects beyond the holder. Before using, the holder should be well oiled, so that the water from the grindstone will not soak into the wood and injure it. This holder is not intended for use on an emery-wheel.

THE casting of motor described in March number has been delayed at the foundry, and cannot be offered as a premium until next month.

THE OSMIUM LAMP.

THE Welsbach osmium incandescent electric lamp was shown for the first time in public at a recent meeting of the Electrotechnical Union in Vienna. Osmium is a metal of the platinum group, and is found almost invariably in combination with iridium. It has the high specific gravity of 22.5 and is the heaviest known body. It is very hard and melts at the temperature of 2,500 degrees Centigrade. It can be brought to a high state of incandescence, emitting a brilliant light before this temperature is reached. Until recently the only uses of the metal have been in the iridium alloy, which has been employed for the tips of gold pens, and for some of its salts, which are used in microscopy and as chemical reagents. In making the lamps the gray osmium powder is reduced to a pasty mass by a suitable mixing ingredient and squirted into filaments. These are about the size of sewing thread. They are wound into their proper form and heated to redness in an atmosphere of ordinary illuminating gas. The heating is accomplished by electricity. The filament contracts considerably and rapidly while hot, and is reduced to metallic osmium in a few minutes. It has not been stated whether the bulbs in which these filaments are placed are exhausted of air or not. The consumption of the lamps is stated to be one and one-half watts per candle-power. It is also claimed that this efficiency is retained throughout the life of the lamp. In some curves which were shown, a lamp beginning at 14.8 candle-power at the end of 200 hours of burning showed 16.5 candle-power and slowly diminished until, after 1,000 hours of burning, it showed 15 candle-power. The light from the lamp is very white. It is stated that the commercial manufacture of the lamp is already well started. They are made for low voltages, twenty-five volts seeming to be standard.—*L'Electricien.*

AN English contemporary states that the government of India has definitely decided in favor of electric lighting and punkah-pulling for a number of military barracks in that country.

ENLARGE your outfit of tools by securing the premiums offered for new subscribers.

VOLTMETERS.

How to Connect and How to Use Them.

Professor Tell, in *Steam Engineering*.

A voltmeter is an instrument that indicates the voltage, or electro-motive force, that acts in a circuit. Electro-motive force is the force that impels acurrent through the circuit — that pushes it along, so to speak. It is substantially equivalent to pressure in steam, and in fact is sometimes spoken of as electric pressure. Electro-motive force is measured in volts, and thus it has come to be common practice to speak of the electro-motive force acting in a circuit as the voltage.

Voltmeters are only made in the form of indicating and recording instruments; no other form is necessary, because all we require to know is what the voltage may be at any instant, which we ascertain by looking at the dial of an indicating instrument; or what the voltage has been at every instant of time during a certain period, which we can find by inspecting the chart of a recording voltmeter.

Recording voltmeters are similar in construction to recording steam gages, and are provided with either a roll of paper or a circular disk, upon which a line is traced showing the voltage at all instants of time within a certain period. In this article we will discuss the indicating voltmeter only. The way in which a voltmeter is connected in the circuit is illustrated in Fig. 1, in which a and m represent the armature and field coils of a generator, and V the voltmeter. As will be seen, one of the wires from the instrument is connected with line p, and the other with line n; thus the voltmeter short-circuits the entire external circuit. If an ammeter were placed in this position, there would be an enormous rush of current through it, sufficient to stall the generator and probably do great damage if a circuit breaker were not connected in the circuit. With a voltmeter, however, the case is very different, the difference being due to the fact that while the resistance of the ammeter is very low, that of the voltmeter is very high. The ammeter is provided with a coil of very large wire consisting of only a few turns — in large instruments, only one turn. The voltmeter, on the other hand, has coils wound with many turns (running up into the thousands) of very fine wire. Owing to this difference in the resistance, while the current passing through an ammeter connected in the position shown in Fig. 1 would be very great,— only limited by the capacity of the generator,— the current passing through the voltmeter would be very small, so small as to be measured in thousandths of an ampere. The actual strength of the current that passes through a voltmeter depends upon the resistance of its coils and the voltage that acts to force a current through them. The resistance does not change, hence the only way in which the strength of the current can be changed is by varying the voltage; therefore the instrument will show variations in voltage if properly calibrated.

From the foregoing it will be seen that ammeters and voltmeters act in precisely the same manner, that is, by the variation in the strength of the current that passes through them. The only difference between the two instruments is that the ammeter is constructed so as to be traversed by very strong currents, and is calibrated so as to show the number of amperes that pass through it; while the voltmeter is constructed so as to be traversed by very weak currents, and is calibrated so as to indicate the voltage that forces the current through it.

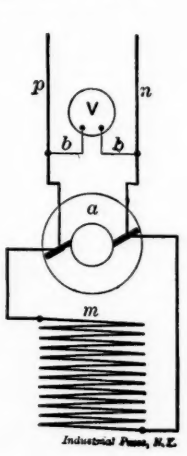


Fig. 1.

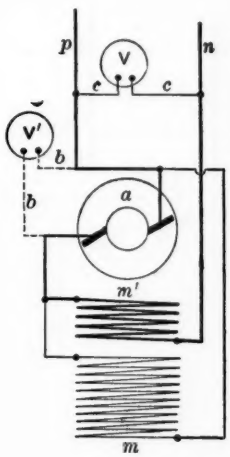


Fig. 2.

If a voltmeter is connected as in Fig. 1, it will indicate the highest voltage acting upon the external circuit, and will show a greater number of volts than if connected across the circuit at any other point farther away from the generator. The reason for this difference is that it requires electro-motive force to drive a current through even the shortest length of conductor, and therefore the voltage left after passing through a portion of the circuit will be less than before passing through it.

In Fig. 1 the generator shown is of the simple shunt type, this being used so as to simplify the diagram. When a compound-wound generator is used, it is necessary to be more particular in connecting the instrument, for if it is connected directly with the armature terminals, it will show a greater number of volts than

actually act upon the external circuit. This fact is illustrated in Fig. 2, in which a properly connected voltmeter is shown at V, while one that only spans the armature is shown at V'. As can be seen at once, the current in wire n cannot reach the armature until it has passed through the field coil m', and, as already stated, a certain amount of electro-motive force is required to drive the current through m'; hence the voltage between the wires p and n cannot be as great as that between b b, so that instrument V' will indicate higher than instrument V.

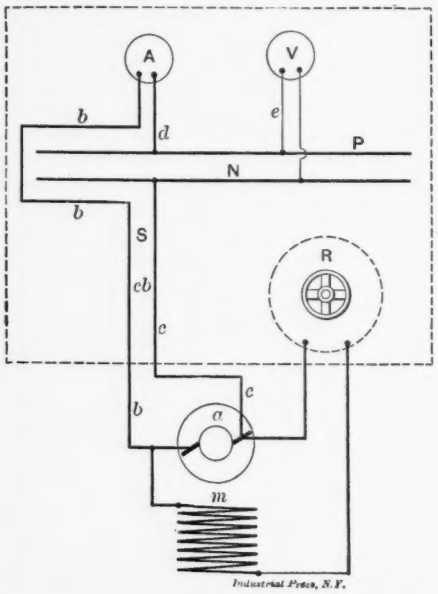


FIG. 3.

The connection of voltmeters, as in Fig. 2, is commonly used in testing generators. If an ammeter is connected in one of the b wires, then by dividing the volts indicated by V' by the number of amperes shown in the ammeter, the resistance of the armature is obtained in ohms. In this way we can determine what the armature resistance is when it is heated by the current. If we note the difference between the volts indicated by the instrument at V and the one at V', and divide this difference by the number of amperes indicated by an ammeter connected in wire n, we will obtain the resistance of the field coil m'. The ammeter connected in n will not show as many amperes as that connected in the b wire, for a portion of the current passing through the latter instrument goes through the shunt field coil m and does not enter wire n. The difference between the readings of the two ammeters,— we will obtain the resistance, in ohms, of the coil m. From this it will be seen that by connecting two voltmeters, as in Fig. 2, and an ammeter in wire b and another one in wire n, we can measure the current flowing through the armature, through the series field coils m' and through the shunt coil m; and we can also measure the resistance of these three parts of the machine when they are traversed by the normal working currents. Such measurements are taken for determining the efficiency of a generator and likewise its regulating qualities.

The connections of a voltmeter on a switchboard are very simple and easily traced out, but for the purpose of making the matter perfectly clear Fig. 3, which shows the connections in the plainest possible manner, is presented. The generator armature and field are shown at a and m. The rectangle in broken lines indicates the switchboard; the lines P and N are the bus bars; an ammeter is shown at A and a voltmeter at V. The latter is connected with both the bus bars, these taking the place of the wires p and n in Fig. 1. The spaces marked S and cb show the position of the main switch and the circuit-breaker. The distributing circuits are taken off from the two bus bars, generally with a small switch in each circuit, so that it may be disconnected independently of all the others. Such switches are not provided, however, unless required.

Fig. 4 is a diagram which will enable us to make clear several uses to which voltmeters are put, and also the meaning of a number of terms very commonly used. In this diagram, a represents the armature of a generator, and m the field. The wires p and n represent a distributing circuit from which a number of lamps or motors, l, are operated. If a voltmeter is placed at V, and is connected with the points s s''' by means of the wires b b, it will show the electro-motive force, or voltage, acting to force the current from p to line n at the points s s'''. This voltage is the total electro-motive force acting upon the circuit, and it acts to drive a current through the first lamp, l, which is also connected with the points s s'''.

As already stated, the current cannot be driven through wire p from s to s' without the expenditure of some electro-motive force, and hence if we place a second voltmeter at V and connect it with the points s s' by means of the wires c c, the indications upon its dial will show the number of volts required to force the current from s to s' through wire p. The electro-motive force acting at the point s to force a current through the lamp l to point s''', or through wire p to point s', is called the potential of the point s. In like manner the electro-motive force acting at point s', to drive the current to point s'', is called the potential of the point s'. The voltage indicated by the instrument V' is called the difference of potential between the points s and s', or the fall of potential from s to s'. It is also spoken of as the line drop between s and s', or simply the drop between s and s'.

The difference of potential between the points s and s''', as indicated by the voltmeter V, is referred to as

the electro-motive force of the circuit, but the voltage acting between the points s' and s'', to force a current through the right-hand lamp l, is generally referred to as the difference of potential between the points s' and s'', and it will be equal to the number of volts indicated upon the voltmeter at V''.

The current flowing through wire n from s'' to s''' will absorb a certain amount of voltage, in the same manner as wire p, and this voltage will be indicated upon an instrument placed at V''' and connected with the points s'' s''', or the difference of potential between these points. As the sum of all the parts cannot be more than the whole, we will find that if the voltage indicated upon the three instruments, V', V'', V''', are added, they will be equal to the voltage indicated by

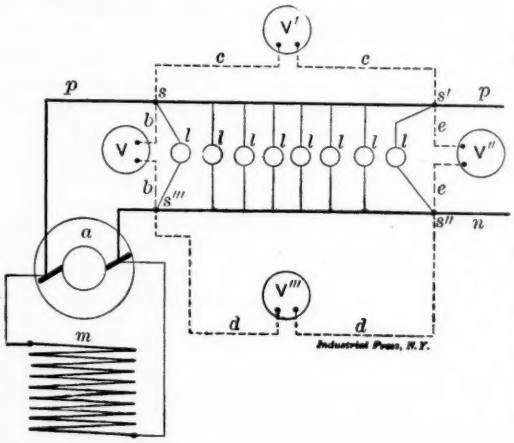


FIG. 4.

the instrument V. If we add the voltages indicated by instruments V' and V''' and deduct it from the reading of V, we will get the volts indicated by V''. From this it will be seen that when we speak of line drop, or line loss, we refer to the voltage absorbed in overcoming the resistance of the circuit wires; that is, to the voltages indicated by the instruments V' and V''' in Fig. 4. The voltage indicated by the voltmeter V' cannot be properly referred to as the line drop as it only shows the drop on one side of the circuit, and it must therefore be called the drop in line p, or the drop on one side of the circuit.

The voltage indicated by the instrument V'' cannot be spoken of as a drop or fall in potential, for it is the electro-motive force acting in the circuits between the points s' and s'', and the active electro-motive force is never referred to as a drop in voltage. Strictly speaking, it would be correct to speak of the indication of voltmeter V'' as the fall of potential between the points s' and s'', but it is not customary to refer to the difference of potential between points on opposite sides of the line in this manner. The word "fall" is used to indicate that the electro-motive force absorbed, or balanced, between two points is lost in overcoming a dead resistance, and not in performing useful work. In some cases, however, this rule is departed from. For example, if we had four or five lamps, of low voltage, connected between the points s' and s'', so as to be in series (that is, so that the current would flow through one after the other from the first one to the last one), we would speak of the electro-motive force absorbed by each one of the lamps as the "fall of potential" through the lamp. We would also speak of it as the "difference of potential" between the terminals of each lamp. To avoid making mistakes in the use of terms it is well to remember that the electromotive force lost between two points in the circuit wires, such as s s', can be referred to as the drop or fall of potential between these points, or we can call it the difference of potential between the two points; but the electro-motive force acting between opposite sides of the circuit, to perform useful work, must be spoken of as a difference of potential or as the electro-motive force, or voltage, acting between these points.

SOMETHING like a sensation has been created in the German metallurgical world by a new process for hardening steel, which is said to be as great an advance upon the Harvey and Krupp methods as these were on those preceding them. The inventor is a steel manufacturer at Mechlenberg. His name is Griebeler. As the result of years of experiment, he claims to have produced a steel which gives double the resisting powers at 50 per cent less cost. Wedges made of the new steel split ordinary steel like so much wood. Projectiles fired at $7\frac{3}{4}$ millimeter plate make an impression of a millimeter, (a millimeter is equal to $\frac{1}{25}''$), while the same projectile would easily penetrate a Krupp plate of $11\frac{3}{4}$ millimeters. Experiments carried out at the High School of Charlottenburg a few days ago are stated to have caused the greatest astonishment.

A WIRELESS telegraph system is being installed between Banana and Ambrizette, and the cable terminals, in the Congo region, by Mr. Paul de Bremaecker of Brussels. At present, telegrams have to be transported by boat to and from Saint Thomas, or Saint Paul de Loanda,—the cable terminals,—and Banana and Ambrizette, on the coast some distance north of these terminals.

TO WRITE on glass: moisten the surface with strong vinegar and write with an aluminum point. Infinitesimal particles of the soft metal are left adhering to the glass, and the writing is fairly permanent.

CORRESPONDENCE.

OUR readers are invited to contribute to this department, but no responsibility is assumed for the opinions expressed in these communications.

Letters for this department should be addressed to Editor of AMATEUR WORK, 85 Water Street, Boston.

They should be plainly written on only one side of the paper, with a top margin of one inch and side margins of one-half inch.

The name and address of the writer must be given, but will not be used, if so requested.

Enclose stamps, if an answer is desired.

In referring to other letters, give the number of the letter referred to, and the date published.

Illustrate the subject when possible by a drawing or photograph with dimensions.

Readers who desire to purchase articles not advertised in our columns will be furnished the addresses of dealers or manufacturers, if stamp is enclosed with request.

(No. 13.) PROVIDENCE, R. I., April 1, 1902.

Can you tell me where I can get the numbers like those used on the "old Dutch clock" described in the December number of AMATEUR WORK?

J. J. B.

The hardware dealers of your city should be able to supply you with these figures; they are the kind used for numbering doors, and come in several sizes. The dealer should be able to send and get them if he does not carry them in stock. It would not be a difficult matter to make drawings and saw them out of sheet brass, as described in the April number.

(No. 14.) MALDEN, MASS., April 10, 1902.

Please advise what kind of stain to use on the Dutch furniture described in the magazine, to get the dark effects seen on similar furniture sold by furniture dealers.

C. E. P.

The dark effects are probably secured by using aniline colors, which may be obtained from any large dealer in paints. The dark green is a mixture of black and yellow; the dark brown, by adding a little black to the brown ordinarily sold. An ounce package of aniline costs from 15 to 25 cents, according to color, and will be sufficient for several pieces of furniture. It is mixed with alcohol and put on with a brush and, when dry, the surplus color is rubbed off with a piece of cloth. A coating of wood stain is sometimes added after the aniline color, but this is a matter of personal choice. A little experimenting with waste pieces of wood will enable the correct color to be ascertained. A final coating of thin shellac is given to prevent wearing.

(No. 15.) PROVIDENCE, R. I., April 11, 1902.

1. Will you kindly explain what is the principle on which Nicola Tesla's "condensing oscillator" works? He claims that it does away with the induction coil. He says: "My oscillator involves the use of vibrations of an electrical condenser which stores electrical energy. This energy is of an explosive nature. When this energy is suddenly released, as in my machine, it produces quickly vibrating oscillations. Though this energy may be enormous in amount, it is not harmful in nature. By means of this machine I may pass *half a million volts* of electricity through a man without injury." Will you explain what he means by quickly varying oscillations? Does electricity oscillate or travel spirally in this case?

2. Can you tell me if Marconi has a ground or water connection in his wireless telegraphy apparatus?

O. L. L.

1. An "oscillator" consists of a secondary coil in which a current of electricity is induced by a primary coil, through which a current of electricity from a condenser (Leyden jar) is passing. There is no iron core required, and the primary and secondary coils have few turns of wire. When electricity accumulated in a condenser, for instance a Leyden jar, is caused to pass through an insulator, i. e., when a disruptive discharge takes place, the current does not simply flow, but appears to oscillate to and from very rapidly, according to the size of the condenser. The high frequency current spoken of appears to travel on the surface of the conductors, and therefore is harmless when passing over the body.

2. Marconi in his wireless telegraphy apparatus has one side of his coherer connected with the earth, also one side of his transmitter.

(No. 16.) PROVIDENCE, R. I., April 17, 1902.

I am making a dynamo of 1¼ H. P., but have not been able to get the discs for the armature core at a reasonable price. Can you tell me where I would be likely to get them? I want discs 6″ in diameter, $\frac{1}{32}$″ thick, with 1½″ hole in center. H. M., Jr.

Carlisle & Finch Co., Cincinnati, Ohio, sell discs for armatures, but I am not advised whether they have the size you desire or not. In the event of their not having them, they can be cheaply made as follows: Procure sufficient soft sheet iron, have same cut on a shearing machine into pieces a trifle over 6″ square. Drill 1½″ holes in the center of each piece. When drilled put them on a 1½″ bolt long enough to contain them all, and fasten firmly together by screwing the nut tight. On the top piece scribe a circle 6″ in diameter, and along this circle, but partly inside of it, drill holes for the wiring. These holes are of the size and number which the wiring requires, according to design. The discs are then mounted on an arbor, put in a lathe and turned down. In this way, armature discs can easily be made of any size.